

ArcScene on a GeoWall

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3-Dimensional Display

It is commonly believed that “two heads are better than one”, but when are three dimensions better than two? The practical answer probably is: “When it is cost effective”. That is a goal of the GeoWall Consortium, an unofficial group of academic and federal agency researchers who are not officially funded as a consortium, but are a consortium in the spirit of open source software, data, and information. Their challenge is to make 3-dimensional (3-D) display systems from low-cost, commodity components (see GeoWall.org). Recent advancements in the necessary hardware components have made such systems possible, and more recent advancements in software from ESRI, and others, are making such systems more usable.

Active vs. Passive

Historically, virtual reality and other stereo display systems have required components at the high end of the technological spectrum, and the high end of price lists. These systems, such as a CAVE™, required multiple proprietary graphics supercomputers, and expensive shutter glasses that were synchronized to the double-refresh rate of the expensive projectors. The combination of these projectors with “active” stereo goggles produced dramatic effects, but the cost was out of reach of most visualization researcher’s budgets.

On the low end of the 3-D display spectrum, printed anaglyph depictions have been employed for many years. In addition to the obvious limitation of non-interactive printed graphics, these red/blue representations restrict the colors that can be used. Limiting use of two of the three primary colors essentially reduces the color choices to green, black and white. Though the passive linear polarization employed by GeoWall systems cut down the total light output, color use restrictions of red/blue anaglyphs is eliminated. Reduced light output is becoming less of a concern as projectors are becoming brighter and cheaper at a rapid pace. These DLP (Digital Light Projection) technology projectors, in combination with affordable PC graphics cards, are making full-color, interactive, digital 3-D data representation practical and affordable for the first time.

A GeoWall system takes the output from a dual video graphics card and routes it to a pair of projectors. The light from the projectors is polarized separately, to produce two separate views. Special projection screen material is required to retain polarization of the light waves. Inexpensive and readily available polarized glasses, such as those used at theme parks, are used to filter the light for each eye. The glasses allow each eye to see only one of the two outputs. Software then sends two separate views to each of the two ports of the graphics card, the user's eyes deceive the brain into believing it is seeing two separate views from two distinct angles, and therefore 3-D depth is perceived from this passive stereo system. Additionally, some GeoWall applications have the capability to add the fourth dimension of time for 3-D animations.

One drawback of stereo display is that not everyone has the ability to perceive depth through stereopsis. About 10% of the population is at least partially "stereo-blind", with up to 1% being fully stereo-blind. Stereo-blindness may be related to the malfunction of one of the eyes (muscular disorder, cataracts, etc.), or may be an entirely neurologic failing. Although virtual 3-D representations of landscapes and other GIS data may not be additionally valuable to the stereo-blind, this is no different than their everyday visual perception of real-life objects. However, most users, even if not experts in GIS data or applications can benefit greatly from 3-D visual representations. After all, that is how most humans perceive the world – visually. Land managers, emergency and disaster response officials, and first responders can all benefit from more accurate, realistic, and interactive digital representations as hardware and software systems become not only more robust, but more pervasive.

3-D Technology for the Masses: Driving Down the Cost

The first GeoWall system, dubbed “AGAVE” at the University of Illinois at Chicago’s Electronic Visualization Laboratory (EVL), was prototyped in February of 2001. Staff at the EVL installed the linux operating system on a commodity PC containing the first-available dual-output graphics card, and ported their CAVE™ library of software to this platform, making the total sum of components very inexpensive, less than \$10,000. This first system was aligned with LEGO™ blocks and super glue, but displayed data impressively in 3-D stereo. It convincingly demonstrated the potential for 3-D display systems that could become very affordable. Since then, applications have been ported to Windows and Macintosh platforms, eliminating architecture barriers.

The moniker “GeoWall” was derived from a combination of “Geology”, because the initial collaborators were actively working to produce geology visualizations, and “Wall”, as in one wall of a CAVE™. Since then, some consortium members have made the case for Geo to represent Geography, or Geometry. Whatever it is called, it remains impressive technology compatible with many kinds of geo-spatial data. Consequently, many are simply referring to these systems as the “Wall”. “GIS-Wall” is now probably not unreasonable.

Leading-edge Hardware, Bleeding-edge Software

Along with the knowledge and information available at the GeoWall web site, several viewing applications and numerous data sets are available for download. However, sometimes the “free” or “open-source” software accompanying leading-edge hardware implies “bleeding-edge”, graduate student software. After the initial excitement of seeing data in 3-D using freely available viewing applications, users invariably begin to ask questions such as: “Can you overlay vectors?” “Can you tell me where I am?” “Can you combine data layers?” “Can you select/deselect points?” “Can you interact with the data?” Until now, the answer always had to be either “No”, or “Maybe someday”.

Commercial GIS 3-D Display

Now, with the release of ArcGIS 3D Analyst 9.0, the answer to the above questions can be “Yes”. ArcScene gives a user perspective views, and ArcScene users know the advantage of perspective views. ArcScene can now give these users two separate stereo

perspective views to simulate a 3-D virtual world. GIS users will be able to combine topographic data with imagery layers, and even create fly-through animations, all within the context of off-the-shelf GIS functionality. The benefits that accompany a hardened, deployed and well-supported commercial software product are not lost on the academic research community.

A Beta II release of ArcScene 9.0 was successfully demonstrated GIS Day 2003, at EPA headquarters in Washington, D.C. Staff from the EDC used ArcScene to display 3-D ASTER satellite imagery from last summer of the Southern California wildfires near San Bernardino, CA. The system was demonstrated to high-level officials from all Federal agencies, congressional staffers, and elementary school students. ESRI staff from the Vienna, VA office present at the event expressed interest in setting up their own Wall. After only an informal discussion at GIS day and a couple of e-mails, their system was up and running.

ArcScene Setup on the Wall

Such a minimal effort required to deploy a GeoWall system is a desire Consortium. The steps to setting up a GeoWall running ArcScene are simple, especially if you already have ArcGIS 9.0 installed. To set the necessary display properties for a graphics card such as an nVidia Quadro4 980 XGL, select “Horizontal Span” in the nView” tab of the system’s Windows display properties pop-up menu (see Figure 1).

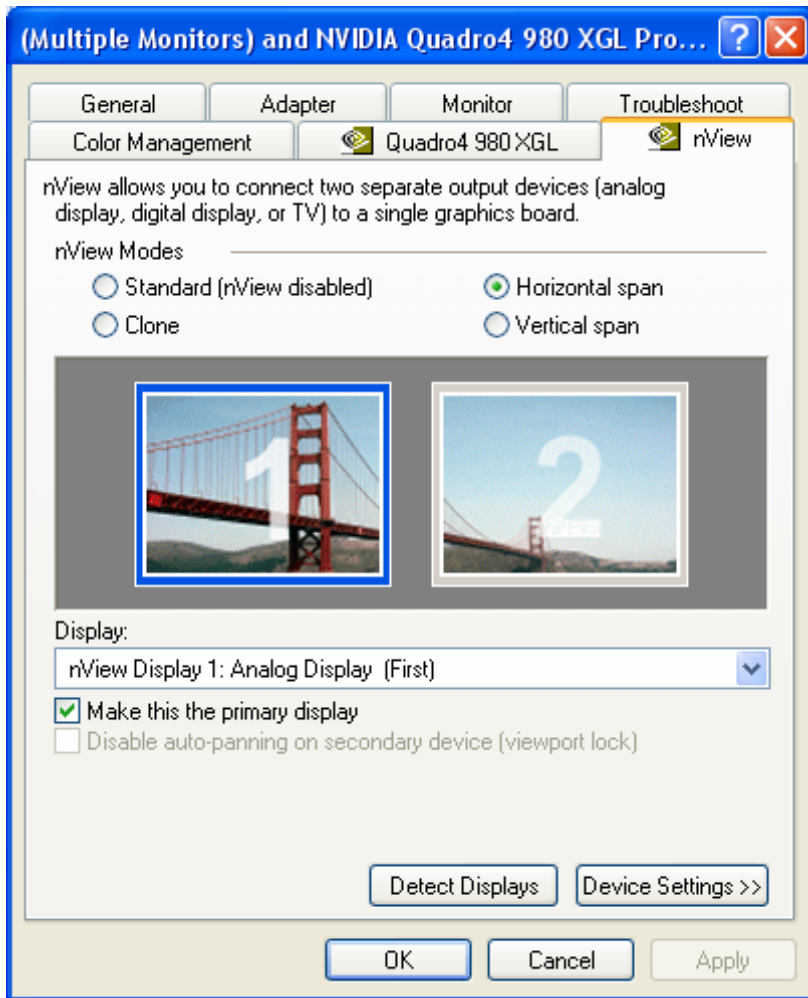


Figure 1: (nView.TIF)

After invoking ArcScene, add data layers as normal. Layer properties, such as Display or Symbology, can be edited as for any data set. The location from where to retrieve the base heights must be assigned for the layer surface. Next, ArcScene's "View Properties" menu item must be selected. To set the necessary view settings, select "Stereo", and "Free" (see Figure 2).

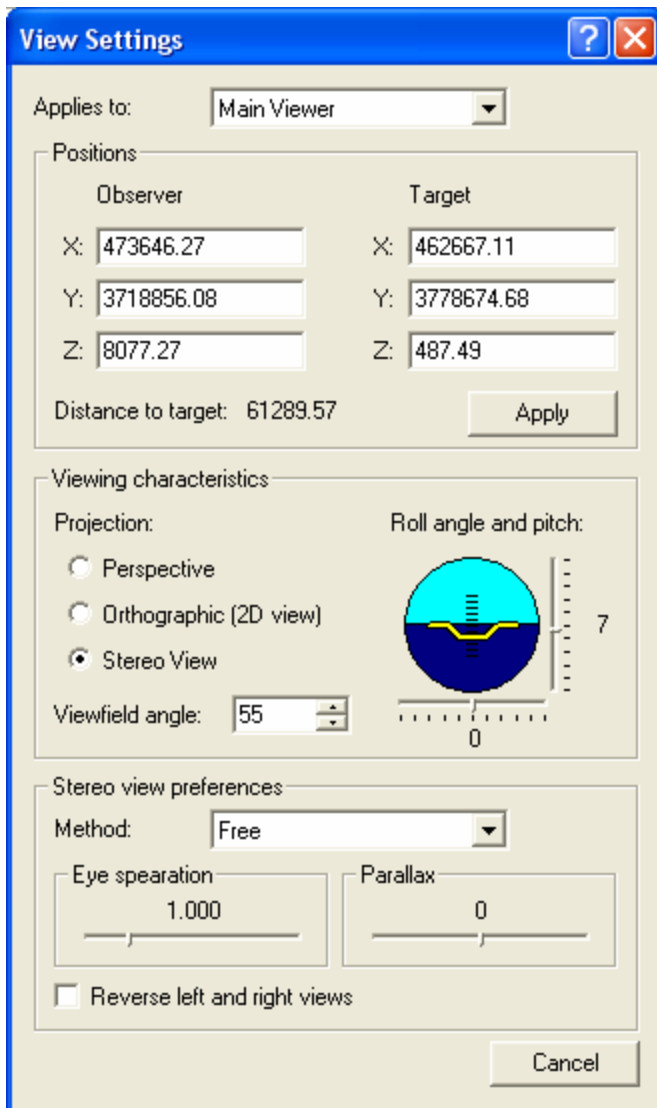


Figure 2: (ArcSceneViewSettings.TIF)

Finally, the Table of Contents must be removed from view to allow ArcScene to display the geometry of the two views correctly (see Figure 3).

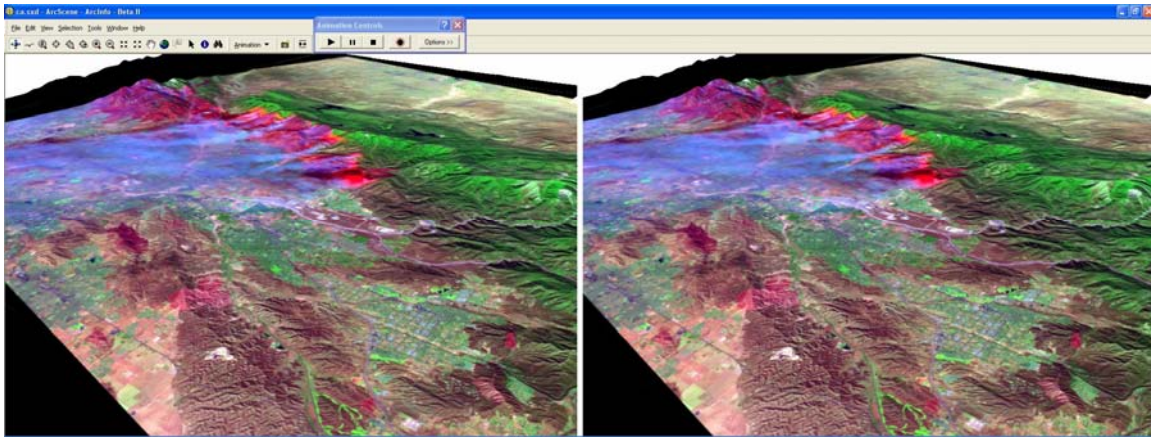


Figure 3: (SanBernardinoAster.TIF)

A more complete description of these steps, with additional screen shots of menu settings, is available at the GeoWall web site at:

<http://geowall.geo.lsa.umich.edu/edc/src/Arc/ArcSceneOnTheWall.doc>

Data Interaction and Analysis Options

The GeoWall web site also contains complete instructions for identifying any components already in hand, or procuring the necessary components, complete with contact information for vendors familiar with GeoWall requirements. Several viewing applications are available for download, as well as numerous data set examples. Versions of StereoAnalyst from Leica Geosystems, Fledermaus from IVS 3D Inc., EarthVision from Dynamic Graphics, Inc., and vGeo from VRCO are also either available for GeoWall systems now, or will be very soon.

GIS software companies such as ESRI can boast their software is so robust, it is even compatible with bleeding-edge university research display technology. The GeoWall

Consortium can to claim that their display systems development is compatible with leading commercial software vendors.

The GeoWall Consortium has been very successful in expanding the use of 3-D display technology. In less than three years, the number of known systems has grown to over 250, and members can no longer keep track of locations or numbers. This may cause one to be reminded of the lyrics from a classic Timbuk 3 hit from the 80's:

“I study nuclear science, I love my classes

I got a crazy teacher, he wears dark glasses

Things are going great, and they're only getting better

I'm doing all right, getting good grades

The future's so bright, I gotta wear shades”

Figure 4: Assistant Secretary of the Interior Lynn Scarlet pointing out the benefits of GeoWall at the 2003 ESRI User Conference in San Diego, CA



(ESRI_UserConf_USGS_4.tif)

(or)

Figure 4: ArcScene on a GeoWall at GIS Day at EPA Headquarters



(GISDay.tif)

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For specific instructions to setup and configure ArcScene 9.0 on a GeoWall system, visit

<http://geowall.geo.lsa.umich.edu/edc/src/Arc/ArcSceneOnTheWall.doc>

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